The Relationship Between 3D MRI Knee Bone Shape and Prevalent and Incident Knee Pain: Data from the Osteoarthritis Initiative

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Background: Incident frequent knee symptoms may represent early knee OA. MRI-detected OA bone pathology is associated with prevalent frequent knee OA symptoms (PFKS) and incident frequent knee OA symptoms (IFKS) in preradiographic knee OA. Active appearance modelling (AAM) enables accurate, 3D quantification of MRIs. Changes in 3D subchondral bone shape derived from AAMs are predictive of incident radiographic knee OA. However, the association of 3D subchondral bone shape with onset of knee symptoms is unknown.

Objectives: To determine the relationship between scalar 3D bone shape and PFKS and IFKS in individuals at increased risk of knee OA.

Methods: AAMs of the femur, tibia and patella and linear discriminant analysis identified vectors best classifying knees having OA vs. no OA. Vectors were scaled such that -1 and +1 represented the mean non-OA and mean OA shapes, respectively. Using a subcohort of 1114 persons with Kellgren Lawrence (KL) zero in both knees at the 12 month visit from the osteoarthritis initiative (OAI) we assessed whether 3D bone shape vector was associated with PFKS or IFKS. We defined PFKS as (pain, aching or stiffness) or medication use for knee symptoms most days of 1 month in the past 12 months. IFKS was defined as those lacking PFKS at baseline but reporting PFKS at any two consecutive annual OAI visits between the 12 and 60-month visits. Logistic regression, using one knee per individual, was used to evaluate the association between 3D bone shape vectors of the femur, tibia and patella and each of PFKS at the 12 month visit and IFKS. All models were adjusted for age, sex, BMI, previous knee injury and previous surgery.

Results: The 3D bone shape vectors of the femur, tibia and patella were not associated with PFKS in the univariable models at the 12 month visit. Adjusted odds ratios (95% CI) for the femur, tibia and patella were; 1.00 (0.71, 1.26), 1.12 (0.90, 1.41), 0.84 (0.66, 1.08) respectively, all $p>0.05$. The 3D bone shape vector was significantly associated with IFKS in the univariable model for the tibia only. The 3D bone shape vectors of the femur, tibia and patella were not associated with IFKS after adjustment for covariates (Table 1). However, BMI, previous knee surgery and knee injury were significantly associated with PFKS and IFKS.

Conclusions: 3D bone shape is not associated with prevalent or incident frequent knee pain in individuals without radiographic OA but at increased risk of knee OA.

Variable	Univariable			Multivariable¶	
	OR	95% CI	p value	OR	95% CI
Femur	0.91	0.66, 1.26	0.58	0.88	0.58, 1.33§
Tibia	1.42	1.04, 1.95	0.03*	1.35	0.98, 1.88§
Patella	0.95	0.68, 1.31	0.75	1.02	0.71, 1.47§

Table 1 – The association between 3D bone vector measures at the 12 month visit and risk of incident frequent knee symptoms by the 60-month visit.

¶Adjusted for Age, BMI, gender, previous surgery, previous injury
*tibia significantly associated in univariable model
§BMI, previous injury and previous surgery significant.